

TRAFFIC SPEED REPORT 78

TRUCK SPEED-WEIGHT STUDY

JANUARY 1964

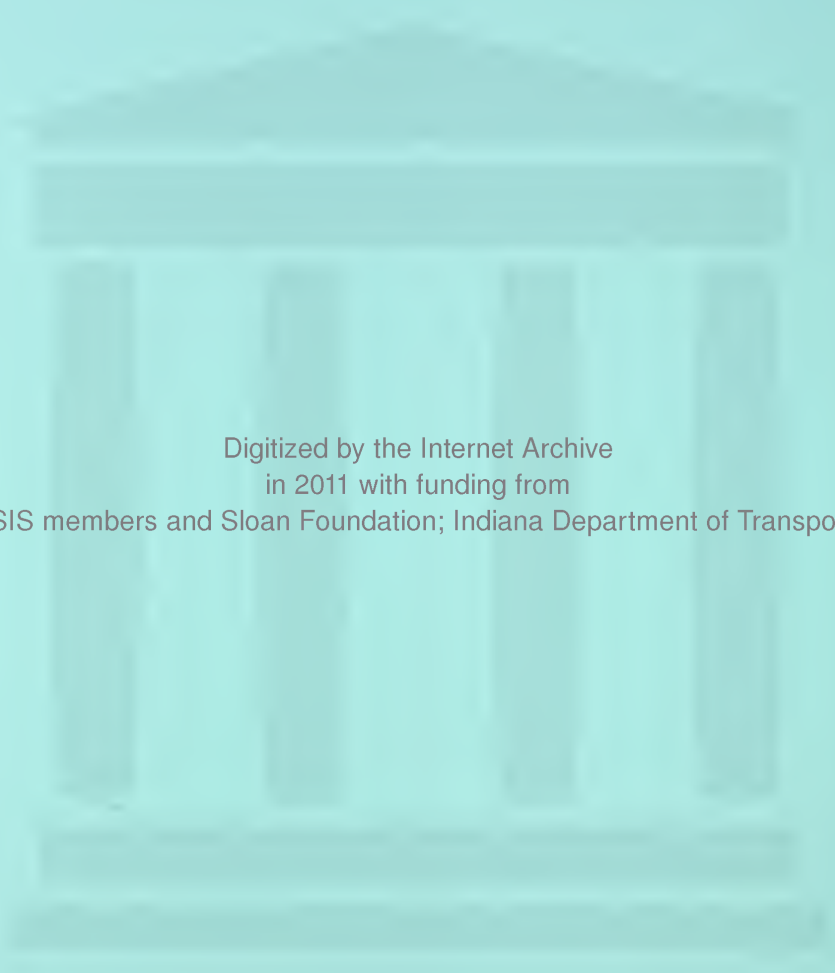
NO. 1

Joint
Highway
Research
Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

by

L.L. SCHULMAN



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Progress Report

"Traffic Speed Report No. 78"

TO: K. B. Woods, Director
Joint Highway Research Project

December 17, 1963

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

File: 8-3-4
Project: C-36-10D

Attached is a Progress Report entitled "Traffic Speed Report No. 78". The results of the 1963 study of the relationship between truck weights and truck speeds are contained herein. The report has been prepared by Mr. L. L. Schulman, graduate assistant on our staff, and was prepared from data obtained during the annual truck study performed by the Highway Planning Survey Section of the Indiana State Highway Commission. The Project has cooperated in this study in a similar manner for many years.

Participation in this study by personnel of the Project was not as great this year as in previous years as the study was conducted about one month later this year thereby causing many conflicts with the beginning of classes for our personnel.

This report will be distributed in the usual manner to the Highway Commission, the Bureau of Public Roads, the State Police, the Office of Traffic Safety and the Traffic Safety Foundation. It is presented to the Board for information and for the record and for approval of such distribution.

Respectfully submitted,

Harold L. Michael

Harold L. Michael, Secretary

HLM:bc

Attachment

Copy:

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Progress Report

TRAFFIC SPEED REPORT NO. 78

by

Lawrence Schulman
Graduate Assistant

Joint Highway Research Project

File No: 8-3-4

Project No: C-36-10D

Purdue University

Lafayette, Indiana

December 17, 1963

TRAFFIC SPEED REPORT NO. 78

Introduction

This report is an analysis of the 1963 annual truck speed-weight study conducted during the months of August and September in conjunction with the Highway Planning Survey Unit of the Indiana State Highway Commission. The Highway Planning Survey Unit makes annual studies of truck weights, size, material hauled and this year included an origin and destination study. Personnel of the Joint Highway Research Project observe the speeds of the trucks at some point along the road and by use of an identical method of classification match the truck weight and speed. Although the Highway Planning Survey Unit makes its observations at twenty locations throughout the state, nine stations have been used annually for the speed-weight study by the Project.

This year, due to a very late data collection schedule, the Project was unable to collect data at all nine of the usual stations. Consequently this report is for only six of the nine stations usually observed. The stations utilized are shown on Figure 1 and are further described as follows:

<u>Station</u>	<u>Highway</u>	<u>Location</u>	<u>Date of obs.</u>	<u>No. of lanes</u>
58B	U.S. 31	0.2 mi S of Southport Road	Aug. 20	4
75	U.S. 41	0.2 mi S of U.S. 41 Bus.	Aug. 21	4
81	U.S. 150	0.5 mi E of S.R. 56	Aug. 23	2
45B	S.R. 67	1.0 mi SW of Muncie	Aug. 29	2
5*	U.S. 30	1.3 mi E of Bourbon	Sept. 23	2
4*	U.S. 31	0.2 mi S of U.S. 6	Sept. 24	2
2*	U.S. 20	0.3 mi W of S.R. 2	Sept. 20	4
14	U.S. 41	0.5 mi S of S.R. 2	Sept. 11	4
42	U.S. 52	at Jct. of S.R. 38	Sept. 16	4

*Not observed in 1963.

Equipment and Field Procedure

The speed data were collected by use of the Electromatic Radar Speed Meter-Model No. S-5. Prior to conducting the study, the Meter had been checked for accuracy by use of a fifth wheel device, and during the study the meter was periodically tested to insure continued accuracy by use of 30 mph and 45 mph tuning forks.

To lessen the effect of the observer on the traffic stream, the meter was placed in a cardboard barrel near the roadway and the observer and recording unit were stationed at least twenty feet from the edge of the roadway. Complete concealment was not found to be practical on modern highways having wide shoulders. The meter was placed approximately three feet from the edge of the pavement at an angle of less than 10° with the centerline of the roadway. Speed inaccuracies are negligible at small angles and corrections were unnecessary.

The speed observations were made on level, tangent sections of the highway between one and three miles from the weighing stations. In all cases, sufficient distance was allowed for the trucks to regain normal cruising speeds since data were desired for "free-moving vehicles." For this report "freemoving vehicle" refers to one which is not hampered by other traffic or effected by a change in speed due to stopping or turning. Care was also taken to minimize the opportunity for the vehicle to turnoff the road.

The speed stations were operated during the same hours as the weighing stations, 8 a.m. to 4 p.m. During the four morning hours the observations were made on vehicles moving in one direction and during the four afternoon hours the apparatus was moved to the other side of the roadway to observe vehicles in the opposite direction.

THEORY OF THE EARTH

The first part of the book is devoted to the study of the earth's structure and composition. It begins with a discussion of the earth's internal layers, including the crust, mantle, and core. The author then discusses the various types of rocks and minerals found in the earth's crust, and how they are formed. This is followed by a chapter on the earth's atmosphere and hydrosphere, and the various processes that shape the earth's surface. The second part of the book is devoted to the study of the earth's history. It begins with a discussion of the earth's origin, and the various theories that have been proposed. This is followed by a chapter on the earth's geological history, and the various events that have shaped the earth's surface. The author then discusses the earth's biological history, and the various organisms that have lived on the earth. The book concludes with a chapter on the earth's future, and the various theories that have been proposed for the earth's ultimate fate.

Procedure and Analysis

For purpose of the analysis the data were classified by truck type - single unit or multi-unit - and by road type - two lane or four lane. The single unit trucks were further classified into those less than 5000 lbs. and those over 5000 lbs. This weight classification corresponds to the existing Indiana speed limits for trucks which are as follows:

65 mph for light (less than 5000 lbs.) trucks

55 mph for heavy (over 5000 lbs.) trucks on 4-lane
highways with a median of 20 ft. or more

50 mph for heavy trucks on other roadways

This classification allowed a comparison of the observed speeds with the legal and "enforced" speed limits. These results are presented in tabular form in Table III.

A breakdown of the data is presented in Tables I and II. The observed values are separated into weight classes and the number observed and average speed within each weight class is shown. The tables also show the average weight, average speed and 95% confidence limits for each truck classification at each station and summaries by truck classification on both types of highway facility. Table IV is a tabulation of the number of observations and average speeds and weights by truck classification for the last fifteen years.

Figures II, III, and IV are cumulative frequency curves by truck classification and by facility type. Figures V and VI indicates the trends in 85th percentile speeds. Figures VII-IX show simple regression curves of truck speed to truck weight.

THEORY OF THE EARTH

The theory of the earth is a branch of geology which deals with the origin and development of the earth and its various parts. It is a science which seeks to explain the processes which have shaped the earth and its features. The theory of the earth is based on the study of the earth's history and its various parts. It is a science which seeks to explain the processes which have shaped the earth and its features.

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Summary of Results

Analysis of Tables I and II show the following average characteristics for the various road and truck classifications:

Single Unit

	2-lane	4-lane	All
No. of Vehicles	167	321	488
Average Speed - mph	41.7	46.2	44.9
Average Weight - lbs	10,300	12,000	11,500

Multi-unit

	2-lane	4-lane	All
No. of Vehicles	126	610	736
Average Speed - mph	42.9	46.4	45.9
Average Weight - lbs	40,170	44,280	43,600

Table III shows that the following percentages of trucks exceeded the existing and enforced speed limits (where the enforced speed limit is 5 miles faster than the legal speed limit).

		Single Unit		Multi-unit
		Light	Heavy	
4-lane 2-lane	Speed Limit	0	7.2	7.9
	Enforced limit	0	.7	.8
	Speed limit	0	.8	5.3
	Enforced limit	0	2.1	.5

From the above table one can conclude that there is a negligible percentage of trucks exceeding the "enforced" speed limit on Indiana highways.

Observation of the steepness of the central portion of the cumulative frequency curves (Fig. II, III, IV) for the heavier trucks indicates that a smaller variation in speeds exist between heavy trucks than between light trucks. These figures also show that the greatest variation in the confidence band for the calculated means occurs for light, single-unit trucks. This may be an indication of too small a sample size in comparison with the other classifications.

Figures V and VI show the plots of the 85th percentile speeds on 2-lane and 4-lane. No trend regression lines have been drawn since the data are widely scattered.

Figures VII-IX show the computed regression lines and equations for the simple linear regression analysis of the speed and weight data. This analysis was done on the LGP-30. These figures show that there is a slight decrease in speed for an increase in weight, but the decrease in most cases is insignificant. Furthermore the r^2 values or the correlation coefficient show that there is little correlation between speed and weight. If a perfect correlation existed, the r^2 value would be 1. In this study the computed r^2 's between speed and weight were as follows:

Equation	r	r^2
2-lane single unit	.0355	.0012
4-lane single unit	.2092	.0437
2-lane multi unit	.0972	.0094
4-lane multi unit	.1853	.0343
Multi unit (total)	.1465	.0214
Single unit (total)	.1048	.0109

It should be noted that the sample size for many of the weight classifications was too small to give a reliable regression line for sample unit trucks and that the largest correlation coefficient observed for multi-unit or total truck classifications was .0343. This indicates little correlation. It can, therefore, be concluded that increasing weight apparently accounts for only a very small part of the observed speed differences.

Table IV indicates that the average speeds of single unit and multi-unit trucks have decreased 3.8 and 3.3 mph respectively from the last observation. This represents a substantial decrease from the slowly rising trend in average speeds which has been occurring. Closer observation also shows that speeds at each of the six stations were in most cases 2-5 mph less for all classes of trucks than they were last year.

Because of this unusual decrease, the radar meter was again calibrated after the study to determine if any operational error was present. The calibration was made by running a vehicle at known speeds past the meter. The results showed that no error existed.

Part of the decrease in the overall average may be due to not observing the three stations in Northern Indiana which in the past have given slightly higher speeds. This is especially true of the 2-lane roadways. However, no explanation is apparent for the observed decrease at each of the individual stations.

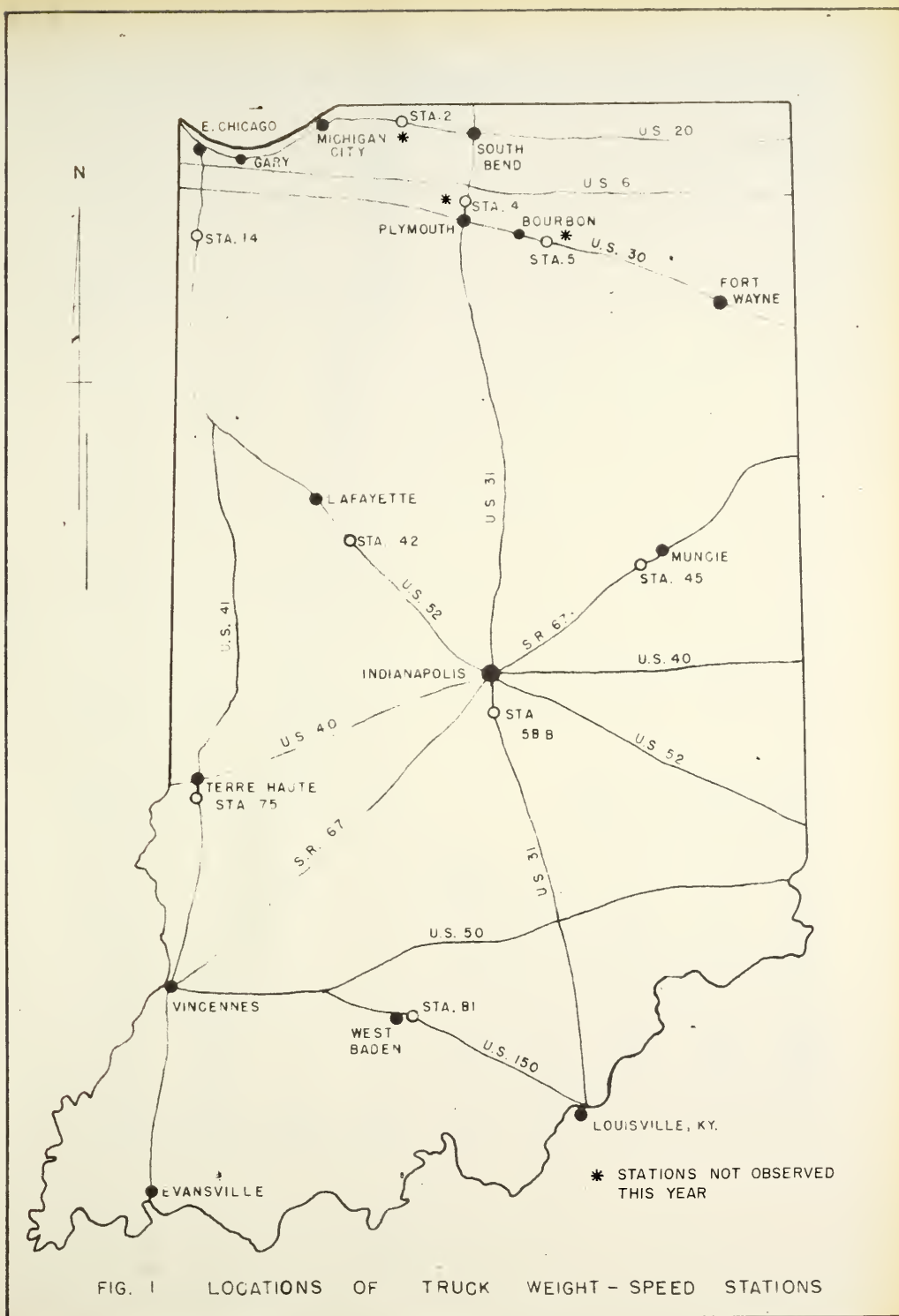


FIG. 1 LOCATIONS OF TRUCK WEIGHT - SPEED STATIONS

PERCENTILE

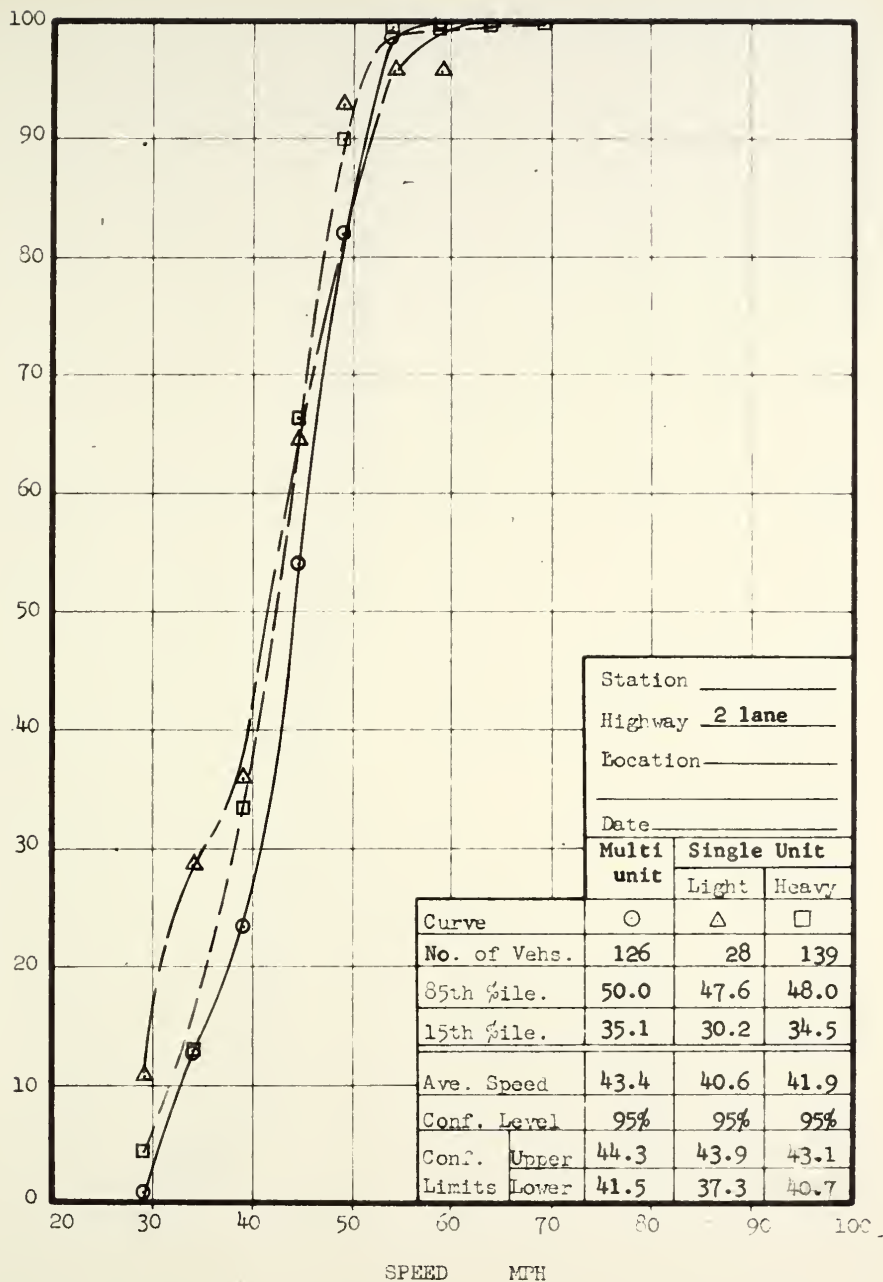


FIGURE II

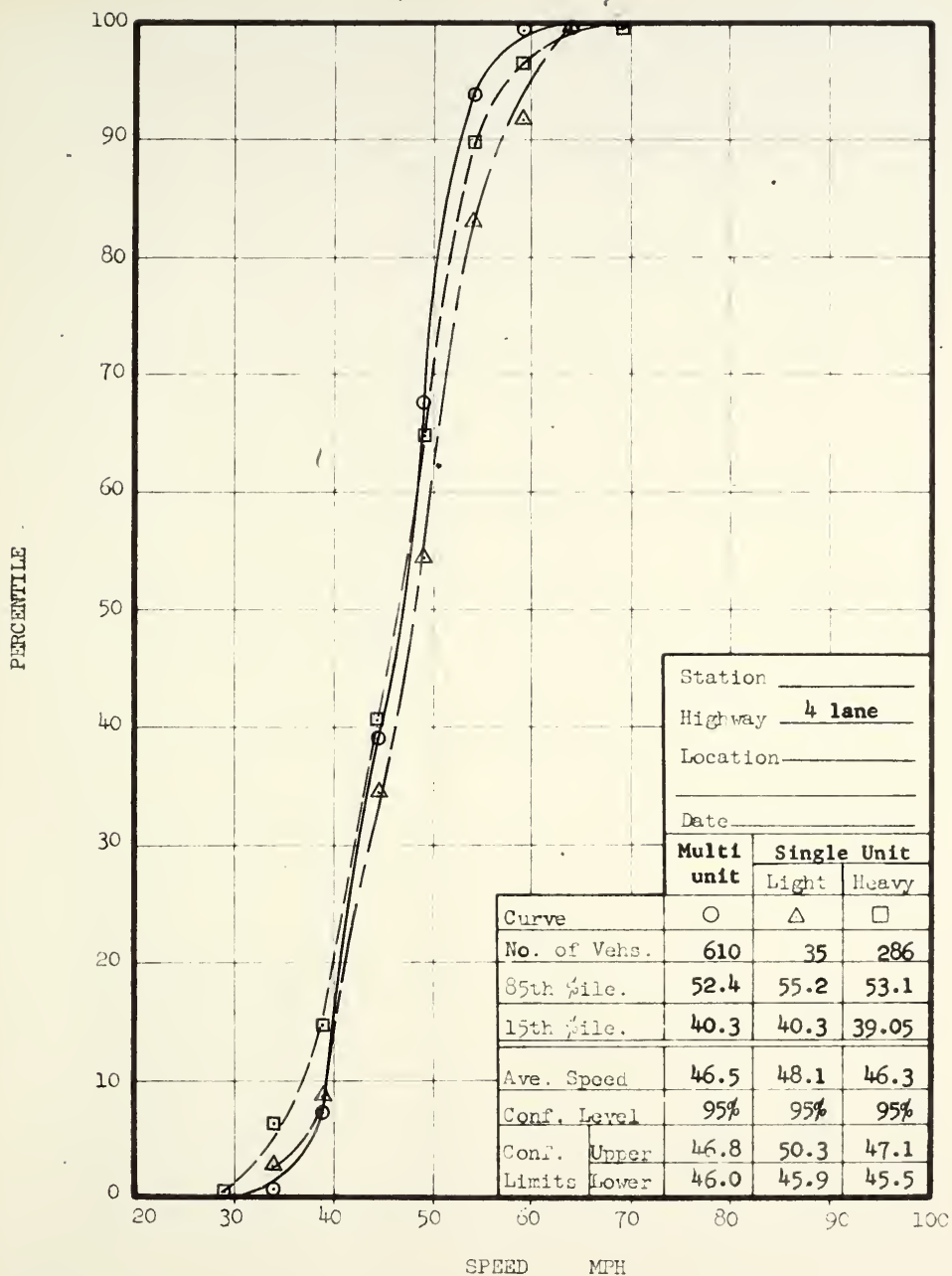


FIGURE III

PERCENTILE

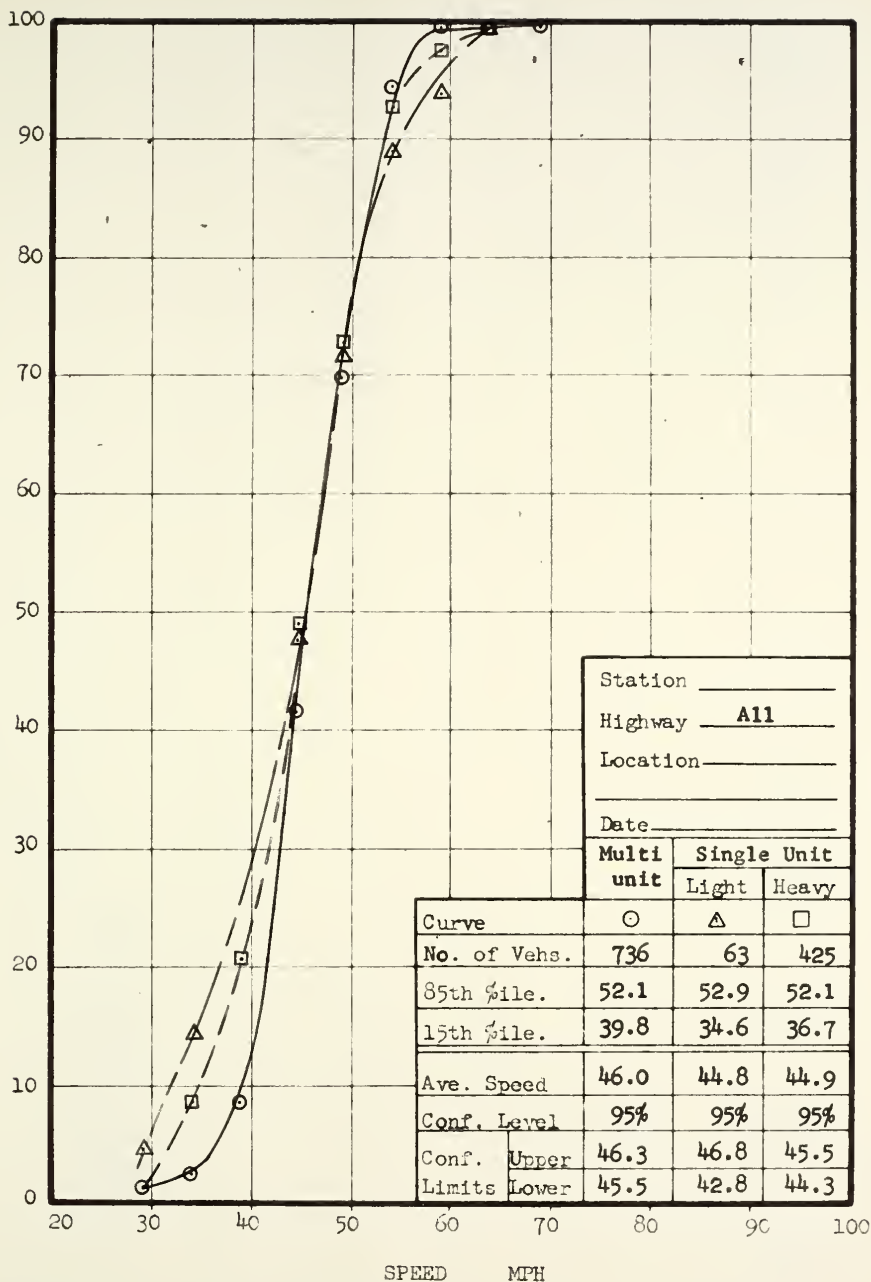


FIGURE IV

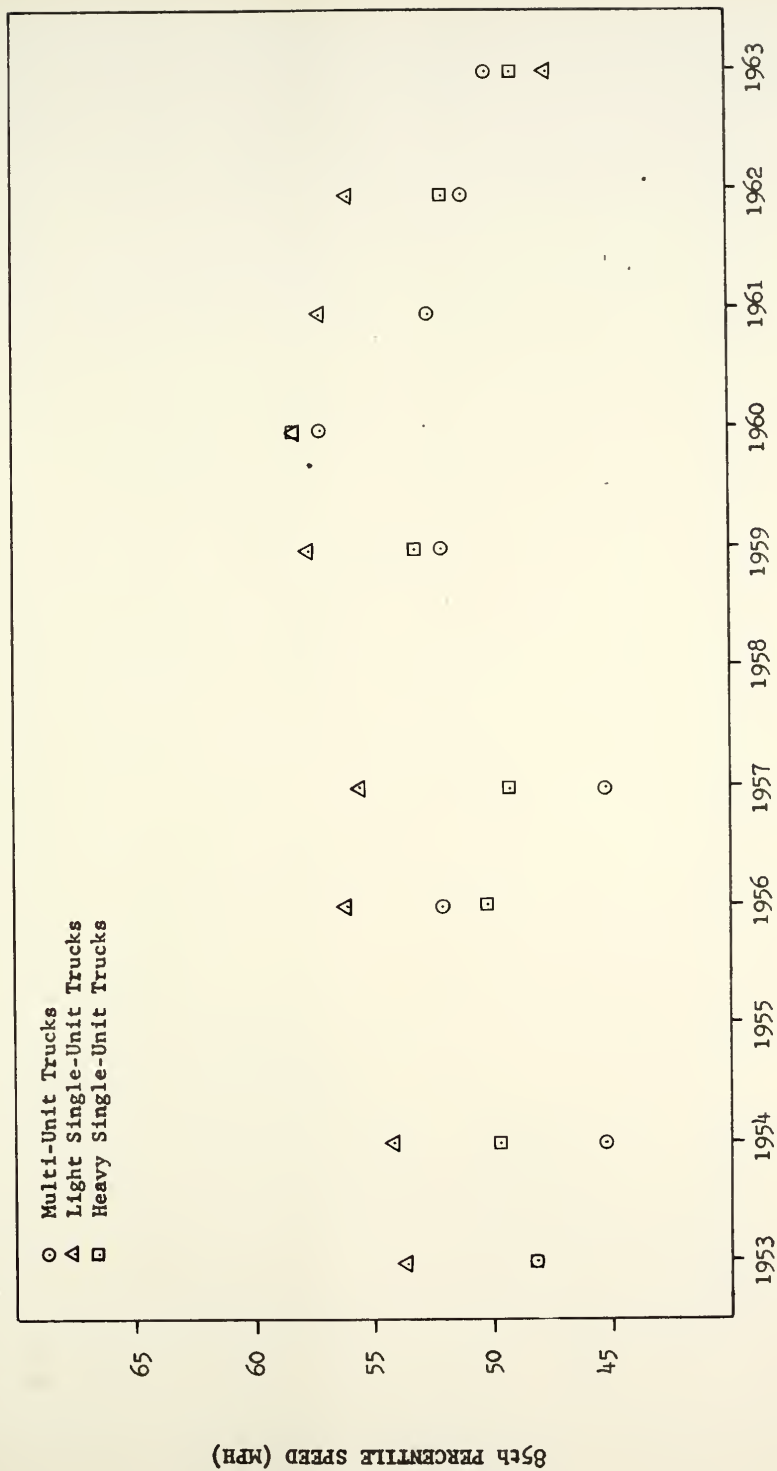


FIGURE V TRENDS IN THE 85th PERCENTILE TRUCK SPEED ON TWO-LANE HIGHWAY (1953-1963)

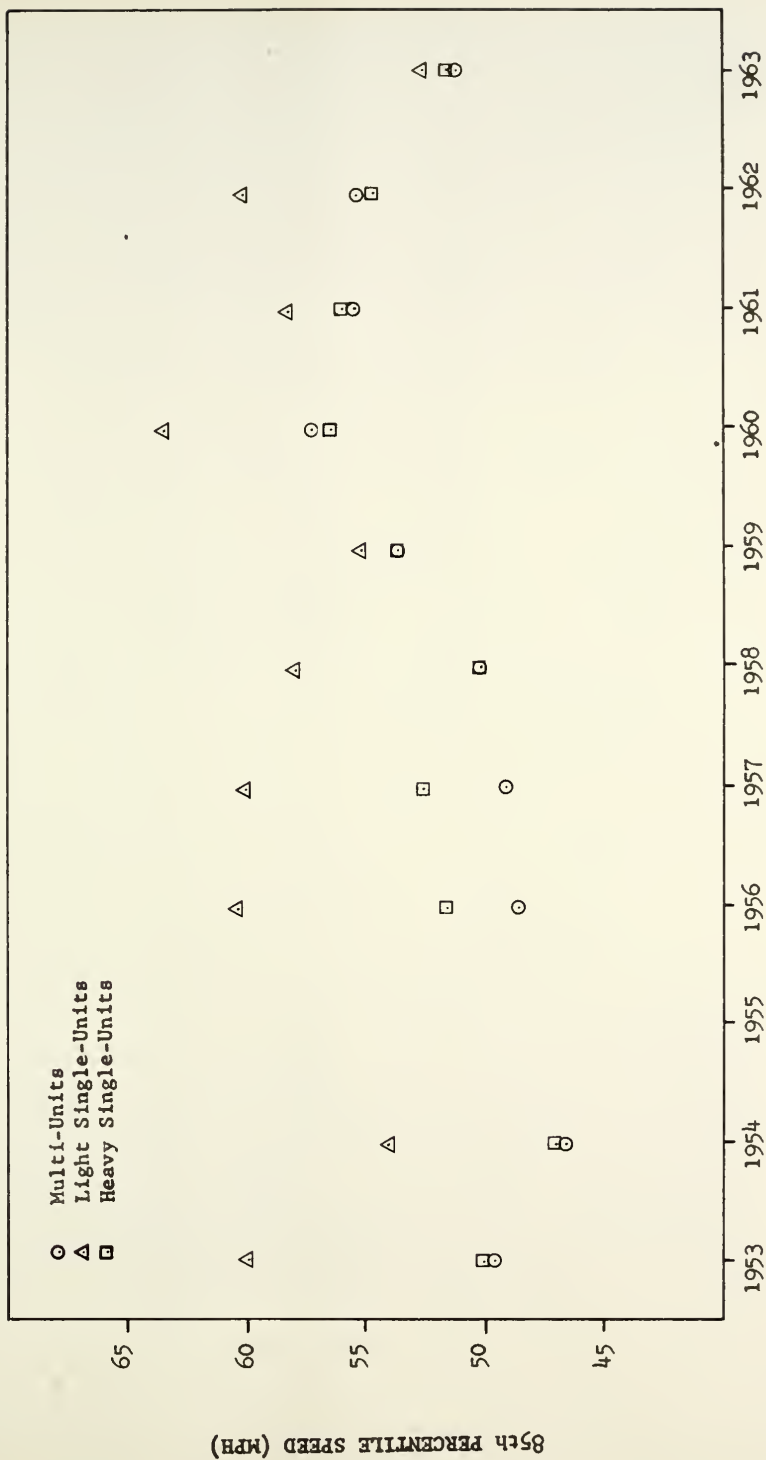


FIGURE VI TRENDS IN 85th PERCENTILE TRUCK SPEEDS ON FOUR-LANE HIGHWAYS (1953-1963)

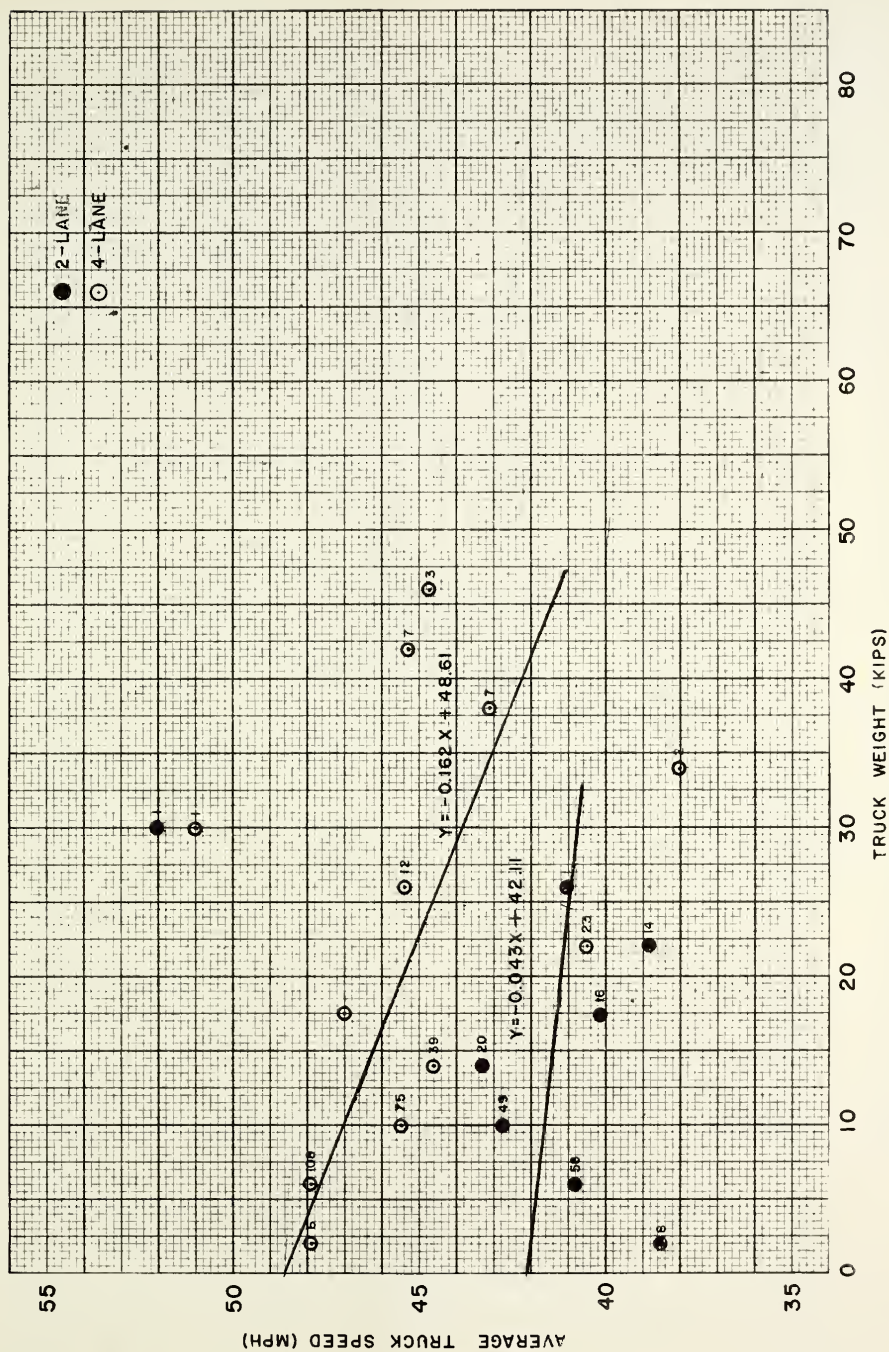


FIGURE VI I REGRESSION ANALYSIS: SINGLE UNIT TRUCKS BY ROADWAY TYPE

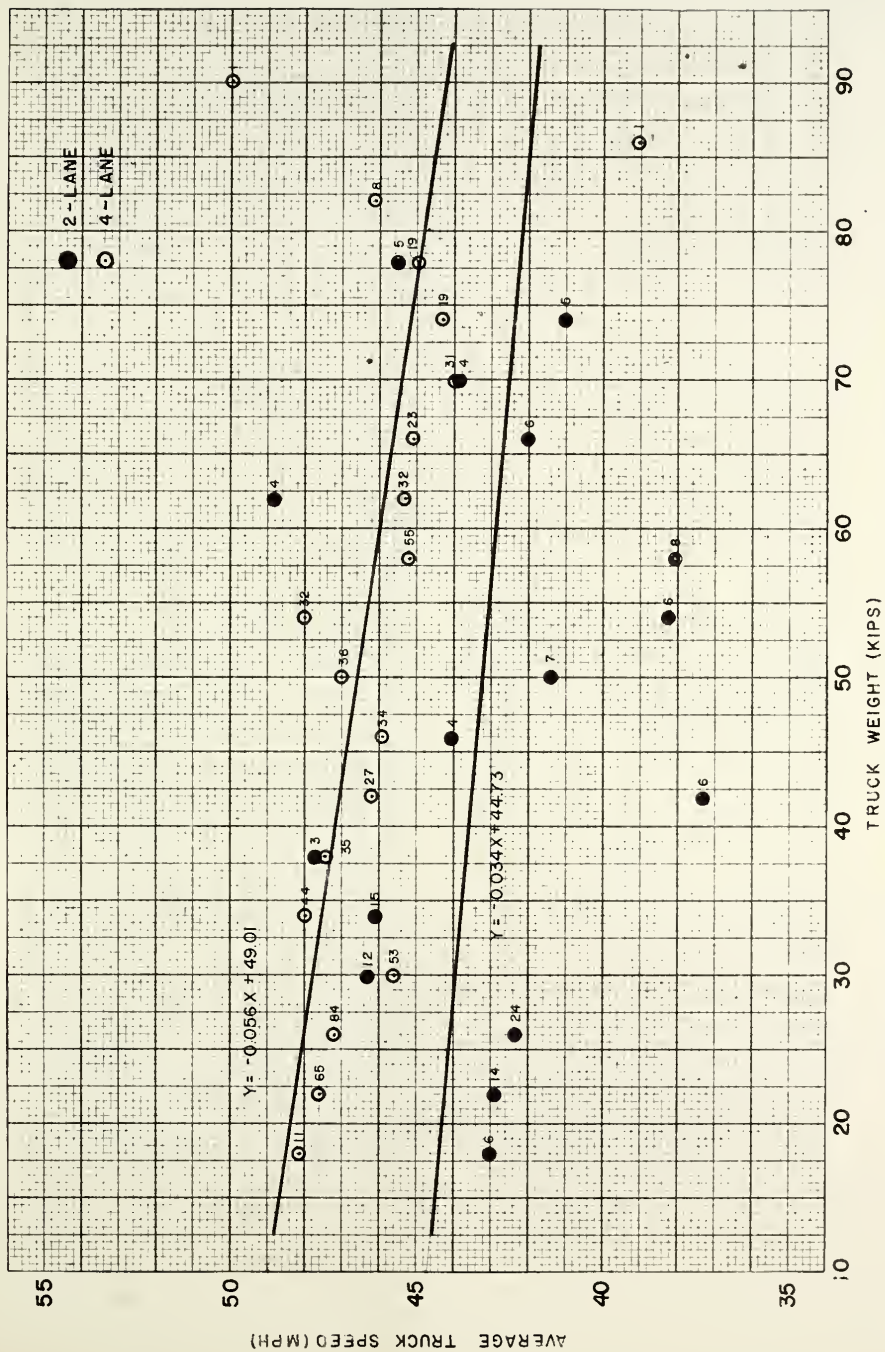


FIGURE VIII REGRESSION ANALYSIS: MULTI UNIT TRUCKS BY ROADWAY TYPE

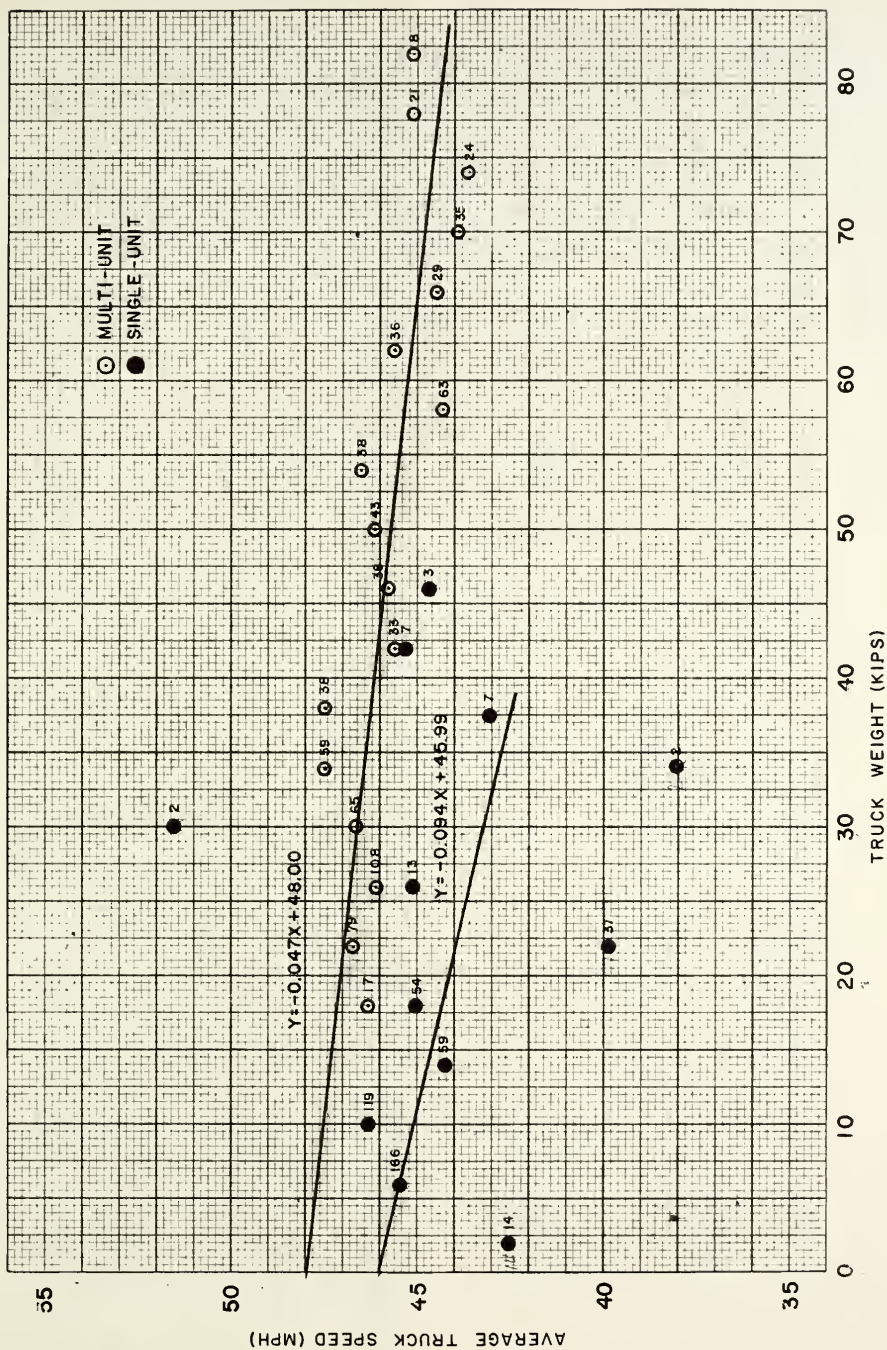


FIGURE IX REGRESSION ANALYSIS: ALL TRUCKS BY TRUCK TYPE

Station			Total					
	145B		75		Total Four-lane		Total Two-lane and Four-lane	
Percent (ADPS)	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks
0-5	0	0	47.7	3	47.9	6	42.5	14
5-10	46.0	6	46.2	14	48.2	29	45.5	49
Total Trucks	6		17		35		63	
Ave. Wt. (lbs.)	4300		4400		4300		4200	
Ave. Speed	46.0		46.5		48.1		44.8	
Conf. Level	95%		95%		95%		95%	
Conf. Upper	48.4		48.2		50.3		46.8	
Limit Lower	43.6		44.8		45.9		42.8	
% Empty								
5-10	46.7	13	45.9	23	47.8	79	45.4	117
10-15	46.6	19	44.3	28	45.5	75	46.3	124
15-20	46.7	11	44.9	10	44.6	39	44.2	59
20-25	43.6	5	44.6	7	47.0	38	45.0	54
25-30	46.5	2	37.9	14	40.5	23	39.9	37
30-35	0	0	40.0	3	45.4	12	45.1	13
35-40	52.0	1	51.0	1	51.0	1	51.5	2
40-45			38.0	1	38.0	2	38.0	2
45-50			32.0	1	43.1	7	43.1	7
50-55			0	0	45.3	7	45.3	7
55-60			35.0	1	44.7	3	44.7	3
Total Trucks	51		89		286		425	
Ave. Wt. (lbs.)	11,300		10,200		13,100		12,600	
Ave. Speed	46.5		43.4		46.3		44.9	
Conf. Level	95%		95%		95%		95%	
Conf. Upper	47.9		45.0		47.1		45.5	
Limit Lower	45.1		41.8		45.5		44.3	
% Empty								

TABLE I SING UNIT THICKNESS (MPH)

Station	Two-lane Highways								Four-lane Highways								Total Two-lane and Four-lane					
	45B		2		1		21		2		1		2		58B				75		Total Four-lane	
Count (A.M.)	Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks		Ave. No. of Loaded Trucks	
0-5	0	0			38.5	8	38.5	8			0	0	0	0	48.0	3	47.7	3	47.9	6	42.5	14
5-15	46.0	6			39.5	14	41.5	20			43.0	1	50.8	4	50.4	10	46.2	14	48.2	29	45.5	49
Total Trucks	6				22		28				1		4		13		17		35		63	
Ave. Hb. lbs.	4300				4000		4100				4200		4500		4300		4400		4300		4200	
Ave. speed	46.0				39.1		40.6				43.0		50.8		49.8		46.5		48.1		44.8	
Conf. interval	95%				95%		95%				95%		95%		95%		95%		95%		95%	
Conf. Upper	48.4				43.0		43.9				43.0		58.3		53.3		48.2		50.3		46.8	
Conf. Lower	43.6				35.2		37.3				43.0		43.3		46.3		44.8		45.9		42.8	
Empty																						
3-5	46.7	13			39.0	25	40.5	38			50.1	7	52.4	8	48.9	41	45.9	23	47.8	79	45.4	117
5-10	46.6	19			40.3	30	42.8	49			51.6	8	47.8	25	47.8	14	44.3	28	45.5	75	46.3	124
10-15	46.7	11			39.1	9	43.3	20			46.0	7	44.7	11	43.5	11	44.9	10	44.6	39	44.2	59
15-20	43.6	5			38.5	11	40.1	16			52.8	4	47.4	8	46.5	19	44.6	7	47.0	38	45.0	54
20-25	46.5	2			37.5	12	38.8	14			45.3	3	44.5	2	44.0	4	37.9	14	40.5	23	39.9	37
25-30	0	0			41.0	1	41.0	1			47.2	5	47.7	3	46.0	1	40.0	3	45.4	12	45.1	13
30-35	52.0	1					52.0	1					0	0	0	0	51.0	1	51.0	1	51.5	2
35-40													0	0	38.0	1	38.0	1	38.0	2	38.0	2
40-45													50.0	1	44.0	5	32.0	1	43.1	7	43.1	7
45-50													41.0	1	46.0	6	0	0	45.3	7	45.3	7
50-55															49.5	2	35.0	1	44.7	3	44.7	3
55-60																						
Total Trucks	51				88		139				34		59		104		89		286		425	
Ave. Hb. (lbs.)	11,300				11,700		11,600				14,500		13,200		15,000		10,200		13,100		12,600	
Ave. Speed	46.5				39.2		41.9				49.4		47.6		47.0		43.4		46.3		44.9	
Conf. interval	95%				95%		95%				95%		95%		95%		95%		95%		95%	
Conf. Upper	47.9				40.4		43.1				51.8		48.8		54.9		45.0		47.1		45.5	
Conf. Lower	45.1				38.0		40.7				47.0		46.4		39.1		41.8		45.5		44.3	
Empty																						

[illegible]

TABLE II MULTI-UNIT TRUCK SPEEDS (MPH)

Station	Two-lane Highways										Four-lane Highways										Total Two-lane and Four-lane			
	45B		5		4		81		Total Two-lane		2		14		42		50B		75				Total Four-lane	
Weight (Kips)	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks	Ave. Speed	No. of Trucks
6-1																								
4-16																								
10-24	44.5	4					40.0	2	43.0	6			51.0	6	45.0	2	45.5	2	42.0	1	48.1	11	46.3	17
24-28	46.5	6					40.1	8	42.9	14			47.4	16	47.6	22	47.2	17	48.4	10	47.6	65	46.7	79
28-32	44.4	14					39.3	10	42.3	24			47.4	30	45.7	26	50.2	19	45.0	9	47.2	84	46.1	108
32-36	46.3	12					---	---	46.3	12			47.1	14	48.4	18	45.5	11	43.9	10	45.6	53	46.6	65
36-40	48.6	10					40.1	5	46.1	15			50.9	12	47.1	22	48.0	6	44.3	4	48.0	44	47.5	59
40-44	47.7	3					---	---	47.7	3			50.1	14	48.6	8	43.2	9	45.3	4	47.5	35	47.5	38
44-48	38.0	5					34.0	1	37.3	6			45.0	8	45.7	11	48.0	8	---	---	46.2	27	44.6	33
48-52	45.0	4					---	---	45.0	4			46.9	12	44.1	10	46.3	10	46.0	2	45.9	34	45.8	38
52-56	45.5	4					36.0	3	41.4	7			48.7	14	48.0	11	43.6	10	47.0	1	47.0	36	46.1	43
56-60	44.6	3					32.0	3	38.3	6			49.5	13	46.8	9	48.0	7	45.3	3	48.0	32	46.5	38
60-64	43.0	2					36.3	6	38.0	8			47.9	20	45.8	12	42.4	16	42.7	7	45.2	55	44.3	63
64-68	48.8	4					---	---	48.8	4			45.8	13	46.3	6	40.2	4	46.0	9	45.3	32	45.6	36
68-72	43.5	4					39.0	2	42.0	6			46.7	11	40.0	2	38.0	4	48.7	6	45.1	23	44.5	29
72-76	45.3	3					39.0	1	43.8	4			47.3	8	47.7	3	41.3	15	44.4	5	43.9	31	43.9	35
76-80	53.0	1					38.0	4	41.0	5			47.9	8	41.3	3	41.7	6	42.5	2	44.3	19	43.6	24
80-84	46.5	2							46.5	2			44.5	6	44.9	8			45.8	5	45.0	19	45.1	21
84-88													45.3	4	47.5	2			46.5	2	46.1	8	46.1	8
88-92													---	---	39.0	1					39.0	1	39.0	1
92-96													50.0	1							50.0	1	50.0	1
96-100																								
Total Trucks	81						45		126				210		176		144		80		610			736
Ave. Wt. (Kips)	39,600						41,200		40,200				45,700		41,400		44,300		46,900		44,300			43,600
Ave. Speed	45.3						38.3		42.9				47.8		46.5		45.1		45.4		46.4			45.9
Conf. Level	95%						95%		95%				95%		95%		95%		95%		95%			95%
Conf. Upper	47.5						39.7		44.3				48.6		47.1		46.3		46.4		46.8			46.3
Conf. Lower	43.5						36.9		41.5				47.0		45.9		43.9		44.4		44.0			45.5
% Empty																								

Station	Single Units						Multiple Units					
	Trucks Weighing Under 5000 lbs.			Trucks Weighing Over 5000 lbs.								
	No. Obs.	% Exceed 65 mph	% Exceed 70 mph	No. Obs.	% Exceed 50 mph	% Exceed 55 mph	No. Obs.	% Exceed 50 mph	% Exceed 55 mph	No. Obs.	% Exceed 50 mph	% Exceed 55 mph
45-B	6	0	0	51	17.6	2.0	81	12.3	1.2	81	12.3	1.2
5	---	---	---	---	---	---	---	---	---	---	---	---
4	---	---	---	---	---	---	---	---	---	---	---	---
81	22	---	---	88	1.1	0	45	0	0	45	0	0
Total	28	0	0	139	7.2	.7	126	7.9	0.8	126	7.9	0.8
Two-lane Highways												
2	---	---	---	---	---	---	No. Obs.	% Exceed 55 mph	% Exceed 60 mph	No. Obs.	% Exceed 55 mph	% Exceed 60 mph
14	1	0	0	34	14.7	5.9	210	8.1	0.5	210	8.1	0.5
42	4	0	0	59	5.1	3.4	176	2.3	0.6	176	2.3	0.6
58-B	13	0	0	104	6.7	1.9	144	4.2	0.7	144	4.2	0.7
75	17	0	0	89	10.1	0	80	2.5	0	80	2.5	0
Total	35	0	0	286	8.4	2.1	610	4.8	0.5	610	4.8	0.5
Summary	63	0	0	425	8.0	1.6	736	5.3	0.5	736	5.3	0.5
Four-lane Highways												

TABLE III
PERCENT OF TRUCKS VIOLATING SPEED LIMITS

